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UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 C.F.R. § 1.53(b))

Attorney Docket No.	MJV-104-E
First Inventor or Application Identifier	Jorge A. Morando
Title	Jet Column and Jet Column Reactor Dross Removing Dross Diluting Pumps
Express Mail Label No.	

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

ADDRESS TO: Assistant Commissioner for Patents, Box Patent Application, Washington, DC 20231

1. [X] * Fee Transmittal Form *(e.g., PTO/SB/17)* *(Submit an original and a duplicate for fee processing)*
2. [X] Specification [Total Pages 16]
   (preferred arrangement set forth below)
   - Descriptive title of the Invention
   - Cross References to Related Applications
   - Statement Regarding Fed sponsored R & D
   - Reference to Microfiche Appendix
   - Background of the Invention
   - Brief Summary of the Invention
   - Brief Description of the Drawings *(if filed)*
   - Detailed Description
   - Claim(s)
   - Abstract of the Disclosure
3. [X] Drawing(s) *(35 U.S.C. 113)* [Total Sheets 8]
4. Oath or Declaration [Total Pages]
   a. [X] Newly executed (original or copy)
   b. [ ] Copy from a prior application (37 C.F.R. § 1.63(d)) *(for continuation/divisional with Box 17 completed)* ***[Note Box 5 below]***
      i. [ ] DELETION OF INVENTOR(S) Signed statement attached deleting inventor(s) named in the prior application, see 37 C.F.R. §§ 1.63(d)(2) and 1.33(b).
5. [ ] Incorporation By Reference *(useable if Box 4b is checked)* The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied under Box 4b, is considered to be part of the disclosure of the accompanying application and is hereby incorporated by reference therein.
6. [ ] Microfiche Computer Program *(Appendix)*
7. Nucleotide and/or Amino Acid Sequence Submission *(if applicable, all necessary)*
   a. [ ] Computer Readable Copy
   b. [ ] Paper Copy (identical to computer copy)
   c. [ ] Statement verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

8. [ ] Assignment Papers (cover sheet & document(s))
9. [ ] 37 C.F.R.§3.73(b) Statement *(when there is an assignee)* [ ] Power of Attorney
10. [ ] English Translation Document *(if applicable)*
11. [ ] Information Disclosure Statement (IDS)/PTO-1449 [ ] Copies of IDS Citations
12. [ ] Preliminary Amendment
13. [ ] Return Receipt Postcard (MPEP 503) *(Should be specifically itemized)*
14. [ ] * Small Entity Statement(s) *(PTO/SB/09-12)* [ ] Statement filed in prior application, Status still proper and desired
15. [ ] Certified Copy of Priority Document(s) *(if foreign priority is claimed)*
16. [ ] Other: .....

NOTE FOR ITEMS 1 & 14: IN ORDER TO BE ENTITLED TO PAY SMALL ENTITY FEES, A SMALL ENTITY STATEMENT IS REQUIRED (37 C.F.R. § 1.27), EXCEPT IF ONE FILED IN A PRIOR APPLICATION IS RELIED UPON (37 C.F.R. § 1.28).

17. If a CONTINUING APPLICATION, *check appropriate box, and supply the requisite information below and in a preliminary amendment:*
    [ ] Continuation [ ] Divisional [X] Continuation-in-part (CIP) of prior application No: ____/____
    Prior application information: Examiner ____ *Group / Art Unit:* ____

18. CORRESPONDENCE ADDRESS

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Signature		Date	10/26/98

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FEE TRANSMITTAL

Patent fees are subject to annual revision on October 1.
These are the fees effective October 1, 1997.
Small Entity payments must be supported by a small entity statement, otherwise large entity fees must be paid. See Forms PTO/SB/09-12.
See 37 C.F.R. §§ 1.27 and 1.28.

TOTAL AMOUNT OF PAYMENT ($) 573

Complete if Known	
Application Number	
Filing Date	
First Named Inventor	Jorge A. Morando
Examiner Name	
Group / Art Unit	
Attorney Docket No.	MJV-104-E-C.I.P.

METHOD OF PAYMENT (check one)

1. ☐ The Commissioner is hereby authorized to charge indicated fees and credit any over payments to:

Deposit Account Number
Deposit Account Name

☐ Charge Any Additional Fee Required Under 37 C.F.R. §§ 1.16 and 1.17

☐ Charge the Issue Fee Set in 37 C.F.R. § 1.18 at the Mailing of the Notice of Allowance

2. ☒ **Payment Enclosed:**
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FEE CALCULATION

1. BASIC FILING FEE

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
101	790	201	395	Utility filing fee	395
106	330	206	165	Design filing fee	
107	540	207	270	Plant filing fee	
108	790	208	395	Reissue filing fee	
114	150	214	75	Provisional filing fee	

SUBTOTAL (1) ($) 395

2. EXTRA CLAIM FEES

	Extra Claims		Fee from below		Fee Paid
Total Claims	25 -20** =	5	X 11	=	55
Independent Claims	6 - 3** =	3	X 41	=	123
Multiple Dependent				=	

**or number previously paid, if greater; For Reissues, see below

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description
103	22	203	11	Claims in excess of 20
102	82	202	41	Independent claims in excess of 3
104	270	204	135	Multiple dependent claim, if not paid
109	82	209	41	** Reissue independent claims over original patent
110	22	210	11	** Reissue claims in excess of 20 and over original patent

SUBTOTAL (2) ($) 178

FEE CALCULATION (continued)

3. ADDITIONAL FEES

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
105	130	205	65	Surcharge - late filing fee or oath	
127	50	227	25	Surcharge - late provisional filing fee or cover sheet.	
139	130	139	130	Non-English specification	
147	2,520	147	2,520	For filing a request for reexamination	
112	920*	112	920*	Requesting publication of SIR prior to Examiner action	
113	1,840*	113	1,840*	Requesting publication of SIR after Examiner action	
115	110	215	55	Extension for reply within first month	
116	400	216	200	Extension for reply within second month	
117	950	217	475	Extension for reply within third month	
118	1,510	218	755	Extension for reply within fourth month	
128	2,060	228	1,030	Extension for reply within fifth month	
119	310	219	155	Notice of Appeal	
120	310	220	155	Filing a brief in support of an appeal	
121	270	221	135	Request for oral hearing	
138	1,510	138	1,510	Petition to institute a public use proceeding	
140	110	240	55	Petition to revive - unavoidable	
141	1,320	241	660	Petition to revive - unintentional	
142	1,320	242	660	Utility issue fee (or reissue)	
143	450	243	225	Design issue fee	
144	670	244	335	Plant issue fee	
122	130	122	130	Petitions to the Commissioner	
123	50	123	50	Petitions related to provisional applications	
126	240	126	240	Submission of Information Disclosure Stmt	
581	40	581	40	Recording each patent assignment per property (times number of properties)	
146	790	246	395	Filing a submission after final rejection (37 CFR 1.129(a))	
149	790	249	395	For each additional invention to be examined (37 CFR 1.129(b))	

Other fee (specify) _____

Other fee (specify) _____

* Reduced by Basic Filing Fee Paid

SUBTOTAL (3) ($)

SUBMITTED BY				Complete (if applicable)	
Typed or Printed Name	Charles W. Chandler			Reg. Number	24,290
Signature		Date	10/20/98	Deposit Account User ID	

JET COLUMN AND JET COLUMN REACTOR DROSS REMOVING DROSS DILUTING PUMPS

Cross-Reference to Related Applications

This application is a continuation-in-part of serial nos. 07/876,636; 08/876,668; and 08/876,669, all filed June 16, 1997, which in turn are continuation-in-part applications of serial no. 08/489,322, filed June 12, 1995 for "Bubble Apparatus for Removing and Diluting Dross in a Steel Treating Bath", and since issued as United States Patent No. 5,683,650, November 4, 1997.

Background of the Invention

This invention pertains to jet-operated pumps for removing or diluting dross from the surface of a bath of molten metal, and more particularly a pump in which a gas is introduced into the pump conduit removing or diluting the dross, in the same direction (a "jet") as that of the moving metal/dross.

This invention further pertains to a pump in which the gas is introduced into the pump conduit in the form of a gas jet through a convergent/divergent nozzle. This invention also pertains to a composite material jet-operated pump for removing or diluting dross from the surface of a bath of molten metal.

Steel utilized in the automotive, construction and appliance industries and the like is formed in very thin strips (.015 to .060 inches thick), which are then passed through a molten bath of either aluminum (aluminizing), zinc (galvanizing) or aluminum/zinc (galvalume). The strip width usually ranges from 30 to 70 inches. To avoid the formation of oxides on the strip's surface that are detrimental to the coating quality, the strip is delivered to the molten bath from a nitrogen/hydrogen-filled furnace through a tubular housing (snout), also filled with the same gas.

Because of the extremely large dimensions of the equipment, and in spite of efforts to prevent air leaks into the furnace, small air leaks occur, generating ferrous oxides (Fe_2O_3, FeO, etc.).

When the steel strip enters the bath, a chemical process occurs in which the aluminum or zinc in the bath reacts with the iron oxides to form dross, aluminum oxides (Al_2O_3) and/or zinc oxides (ZnO). The released free iron settles to the bottom of the molten metal pot. Because of their slightly lower density in the molten metal, alumina (Al_2O_3) and zinc oxide (ZnO), remain in suspension or float to the surface. This dross accumulates in the area enclosed by the snout. Since the dross is generally a very hard ceramic and usually contains large particulates that adhere to the steel strip being processed, a defective coating, having a poor appearance and high rejection rates may result.

In U.S. Patent 5,683,650, a bubble-operated pump is disclosed in which an inert gas is introduced into a conduit having its inlet end disposed beneath the surface of a bath of molten metal. The conduit is generally U-shaped with a pair of upright legs. One leg has an inlet opening in the dross layer. The other leg has an outlet opening disposed outside of the snout housing which contains the dross. In a dross-diluting version, the positioning of the inlet and outlet is reversed. A gas is introduced in the outlet leg in a direction at right angles to the motion of the dross/metal. Upon being introduced into the conduit, the gas creates spaced apart bubbles which induce the flow of metal/dross toward the outlet opening. This pump is a reliable and inexpensive mechanism having no

moving parts for removing dross from the surface of a molten metal bath enclosed in a delivery snout.

Moreover, the pump comprises a one-piece tubular conduit having an inlet side for receiving molten metal and an outlet side for discharging the metal. A source of an inert gas such as nitrogen (or argon) is connected in the outlet side of the conduit to produce the stream of rising bubbles. As the nitrogen bubbles upwards toward the surface, it creates a suction effect in the inlet side of the conduit generating a flow of metal in the same direction. However, in certain instances, the gas creates a fluidic blockage, retarding the flow.

Summary of the Invention

The broad purpose of the present invention is to provide an improved dross removing or diluting pump by providing a U-shaped conduit having its inlet and outlet openings disposed in the bath of metal. The gas is introduced into the conduit adjacent a lower portion in a direction that coincides with the path of motion of the molten metal/dross as it moves towards the outlet opening. The momentum of the gas assists in the molten metal flow. The direction at which the gas is introduced obviates any tendency of the gas to block the metal flow. Throughout this specification, the "flow" is interchangeably referred to as dross and molten metal as the material being pumped is generally some combination of the two.

Another purpose of the present invention is to provide an improved dross removing or diluting pump in which the body of the pump is made of different materials. The gas inlet conduit is formed of a graphite tube with a ceramic

sleeve to protect the tube above the metal line from air burning while the remaining components are constructed of ceramic, graphite, or special alloys depending upon the metal into which the pump is intended to be submerged.

Another purpose of the present invention is to provide a further improved dross removing or diluting pump. Particularly, a gas jet is introduced into the U-shaped conduit and into a converging/diverging nozzle in the same direction as the dross and/or molten metal is moving.

Still further objects and advantages of the invention will become apparent to those skilled in the art to which the invention pertains upon reference to the following detailed description.

Description of the Drawings

The description refer to the accompanying drawings in which like reference characters refer to like parts throughout the several views and in which:

FIGURE 1 is a schematic sectional view of a molten metal bath showing the location of a preferred dross removal pump.

FIGURE 2 is an enlarged sectional view as seen along lines 2-2 of Figure 1;

FIGURE 3 is an enlarged sectional view as seen along lines 3-3 of Figure 1 illustrating the dross removal location;

FIGURE 4 is a longitudinal sectional view of a preferred dross removal pump;

FIGURE 5 is an enlarged sectional view as seen along lines 5-5 of Figure 4;

FIGURE 6 illustrates an inert gas delivery system schematic for a continuous gas flow arrangement;

FIGURE 7 illustrates an inert gas delivery system schematic for a pulsating gas flow arrangement;

FIGURE 8 is a longitudinal sectional view of another embodiment of the dross removal pump;

FIGURE 9 is a view as seen along lines 9-9 of Figure 8;

FIGURE 10 is a longitudinal sectional view of still another preferred dross removal pump;

FIGURE 11 is an enlarged sectional view of the converging/diverging nozzle of the pump of Figure 10;

FIGURE 12 is an enlarged sectional view (from the front of Figure 1) of a dross diluting pump;

FIGURE 13 is an enlarged sectional view (from the rear of Figure 1) of an alternative dross diluting pump; and

FIGURE 14 is an enlarged sectional view (from the rear of Figure 1) of a further alternative dross diluting pump.

Description of the Preferred Embodiment

Referring to the drawings, Figure 1 illustrates a conventional heated metal pot 10, which for illustrative purposes contains a bath of molten aluminum 12. The bath has a top surface 14, usually referred as to the molten metal line. A continuous moving strip of low carbon steel 16 is introduced into the bath from a furnace (not shown) in the conventional manner as illustrated in Figure 3. The

strip passes around a sink roll 17, and tensor roll 17A while submerged in the bath, so that the surface of the strip picks up an aluminum coating.

Strip 16 is delivered to the bath through a conventional tubular snout housing 18. The interior of the housing contains an inert gas, such as nitrogen, or a mix of nitrogen and hydrogen which, as is well known to those skilled in the art, is useful in preventing the steel strip from oxidizing. Oxidation damages the coating being applied to the strip.

The lower exit opening 20 of the snout housing is disposed 6" to 12" below top surface 14 of the bath in order to assure a sealed area for the inert gas filling the furnace and the snout. The steel strip enters the bath through lower opening 20 of the snout housing, submerged into the metal by the rotating rolls as shown in Figures 2 and 3. The strip emerges from the bath and passes toward its destination.

The chemical reaction occurring between the steel strip, the steel strip oxides and the aluminum or zinc bath creates a dross layer 21 that accumulates at surface 14 and is particularly heavy inside the snout housing. An inert gas jet-operated dross removal pump means 22 removes dross from layer 21. A second inert gas jet-operated dross diluting pump means 24 delivers metal into the dross layer inside the snout housing to dilute the dross.

Referring to Figures 4 and 5, the dross removal pump (a jet column reactor) has a generally U-shaped tubular conduit 26. The tubular conduit can be manufactured from different materials depending upon the particular molten metal in the bath. In a zinc galvanizing bath, conduit 26 can be manufactured

from a stainless steel material or other super alloy materials available from Alphatech Inc., of Cadiz, Kentucky specially formulated for resistance to zinc at temperatures up to 1400□F. In galvalume (aluminum and zinc) or aluminum, conduit 26 can be manufactured from any ceramic material resistant to these molten metals, examples of which are also available from Alphatech, Inc.

The diameter of conduit 26 depends upon the amount of dross flow expected to be removed by the pump. For most existing galvanizing and aluminizing lines, a tube diameter of 2.5" to 3" should be sufficient.

The conduit has an upper inlet opening 28 formed at an angle of 45□ to 60□ with respect to the vertical leg of the conduit and is supported in dross layer 21 of the bath. Conduit 26 has an outlet opening 30 formed at right angles with respect to the outlet leg of the conduit, as shown in Figure 4. Opening 30 is disposed 2" to 6" below dross layer 21. Both inlet opening 28 and outlet opening 30 face upwardly. The outlet leg of the pump is supported in a vertical position so that the dross enters through the inlet opening, passes vertically downwardly and then rises vertically along an axis of motion 32.

Pump body 34, in this particular application for molten aluminum, is manufactured from a ceramic material with an upper portion connected to an upper support 36. The pump body 34 essentially comprises a second conduit having an upper inlet opening 38 for receiving an inert gas from a source 40. The pump body has an internal passage 42 which passes from inlet opening 38 down toward a position beneath and aligned with axis 32. A gas opening 44 fluidly connects passage 42 to the interior of the leg, terminating with outlet

opening 30. Opening 44 is directly aligned with the path of motion of the dross -- as defined by the axis of motion 32--as it rises in the outlet leg of the conduit. The gas opening is illustrated as a single opening, however, it can comprise a series of gas injecting nozzles, each having a diameter of .020" to .500" to form a gas jet into the conduit. The gas jet coalesces and forms bubbles that rise in the same direction as the motion of the dross. If high pressure gas is used, the gas momentum will add to the dross velocity and improve the efficiency of the pump. The pump apparatus involves no moving parts exposed to the molten metal.

Figures 6 and 7 show the means for modulating the pressure of the inert gas being received from a compressed gas tank 40. The gas may be either gaseous or liquid nitrogen, argon or helium. A coarse pressure regulator 80 is mounted on the tank for regulating the pressure down from a range of 3000/2000 p.s.i. to 200 plus or minus 100 p.s.i.

A conduit 82 delivers the gas from source 46 to the pump. Gas flow meter 84 is connected in the conduit for measuring the gas flow from 0 to 100 cfh. Higher gas flows may be required for a larger conduit pump body.

A regulator 86 is connected in conduit 82, downstream of the gas flow meter. Regulator 86 is a fine adjusting pressure regulator for regulating pressure down from 200 plus or minus 100 p.s.i. to 100 p.s.i. plus or minus 30 p.s.i. Lower or higher pressures may be required for different applications.

A pressure gage 88 is connected in the conduit for measuring the pressure and range from 0 to 100 p.s.i. A shut-off valve 90 is connected between compressed gas tank 40 and the gas flow meter. A bypass conduit 96

is connected around the gas flow meter and has a shut-off valve 92. A shut-off valve 94 is mounted between pressure gage 88 and conduit 82.

When the jet column reactor is being started up, valves 90 and 94 are opened to pass gas from the compressed gas tank to the pump. The gas is gradually increased by observing gas flow meter 84 and pressure gage 88. When the gas pressure and flow rate have reached acceptable levels, valve 90 is closed and valve 92 is opened so that the gas passes around the gas flow meter. In addition, valve 94 is closed to isolate the pressure gage. Both the flow meter and the pressure gage are isolated in order to protect them from the pulsations that occur in the system. The system provides a continuous flow of gas to the pump.

Figure 7 illustrates a control system similar to Figure 6, but in which a solenoid valve 98 is connected in the conduit with an on/off timing device 100 providing an intermittent charge of gas and which can be regulated between 0 to 2 seconds between charges. For illustrative purposes, almost 20,000 pounds per hour of dross may be removed from the pot using 40 standard cubic feet per hour of nitrogen at 15 to 25 p.s.i.

The jet column reactor is illustrated for removing dross from molten aluminum, however, it can also be used with slight modifications for Zn, Mg, ZnAl alloys and/or recirculating the aluminum in a bath.

Referring to Figures 8 and 9, dross removal pump 122 includes a generally U-shaped tubular conduit 126. The tubular conduit can be manufactured from different materials, depending on the particular molten metal

bath. In a zinc galvanizing bath, conduit 126 can be manufactured from a stainless steel material. In galvalume (aluminum and zinc) or aluminum, conduit 126 can be manufactured from any ceramic material resistant to molten metals.

The diameter of conduit 126 depends upon the amount of dross flow expected to be removed by the pump. For most existing galvanizing and aluminizing lines, a tube diameter of 2.5 to 3 inches should be sufficient.

Conduit 126 has a vertical inlet conduit leg 127 with an upper inlet opening 128 formed at an angle of 45□ to 60□ with respect to the vertical inlet leg of the conduit, and supported in dross layer 21. Conduit 126 has a vertical outlet leg 129 with an upper outlet opening 130 as shown in Figure 8. Opening 130 is disposed 2 to 6 inches below dross layer 21. Inlet opening 128 and outlet opening 130 face upwardly. Leg 129 has a hollow lower extension 131.

A pump body 132 is attached to conduit 126. Body 132, in this particular application for molten aluminum, is manufactured from a graphite material. Body 132 has an inclined internal gas passage 134 with a lower vertical outlet connected to an opening 136 in the lower extension of conduit 126. Opening 136 is aligned with the path of motion of the dross as it rises through outlet leg 129 along vertical axis 138.

Body 132 has an internally threaded end 140. An elongated vertical graphite tube 142 has a lower end threadably connected to threaded end 140, below the metal line, and an upper enlarged end 144 supported by any suitable means 145 above the metal line. A source 146 of an inert gas, such as nitrogen, is connected by conduit means 148 to a gas passage 150 in tube 142. Passage

150 is connected to passage 134 for delivering gas under pressure in the form of a jet to opening 136. Tube 142 is encased in a ceramic sleeve 152 to prevent air burning of the graphite tube above the metal line.

The gas can be delivered either in a continuous or an intermittent form. In either case the gas emerges through opening 136 and forms a series of spaced bubbles 154 because of surface tension. The bubbles rise in the molten aluminum and dross. The rising bubbles entrap sections of molten aluminum and dross between them and carry them upwardly in the direction of arrow 156.

By applying an intermittent flow of gas as shown in Figure 7, the utilization of the gas can be optimized by adjusting the frequency of the jet and bubble formation and the expansion rate to match a particular application. The rising bubbles induce a flow of molten metal towards outlet opening 130, generating a suction at inlet opening 128 which causes the dross located on the surface of the bath to move in the direction of arrow 148 into the inlet opening. A flow is created in conduit 126, thereby scavenging the dross from inside snout housing 18 to a location outside the housing where it can be skimmed off or removed by conventional means.

Referring to Figures 10 and 11, a jet column dross removal pump 222 having a generally U-shaped tubular conduit 226 is depicted. The tubular conduit can be manufactured from different materials depending upon the particular molten metal in the bath. In a zinc galvanizing bath, conduit 226 can be manufactured from a stainless steel material or another alloy specially formulated for resistance to zinc at temperatures up to 1400□F. In galvalume (aluminum

and zinc) or aluminum, conduit 226 can be manufactured from any ceramic material resistant to these molten metals.

The diameter of inlet opening 228 of conduit 226 depends upon the amount of dross flow expected to be removed by the pump. For most existing galvanizing and aluminizing lines, a tube diameter of 2.5" to 3" should be sufficient. The conduit has an upper inlet opening 228 formed at an angle of 45□ to 60□ with respect to the vertical inlet leg of the conduit and supported in dross layer 21 of the bath. Conduit 226 has an outlet opening 230 formed at right angles with respect to the outlet leg of the conduit, as shown in Figure 10. Opening 230 is disposed 2" to 6" below dross layer 21. Both inlet opening 228 and outlet opening 230 face upwardly. The outlet end of the pump is supported in a vertical position so that the dross enters through the inlet opening, passes vertically downwardly and then rises vertically along an axis of motion 232.

Pump body 234, in this particular application for molten aluminum is made from a ceramic material with an upper portion connected to an upper support 236. The pump body comprises a second conduit having an upper inlet opening 238 for receiving an inert gas from a source 240. The pump body has an internal passage 242 which passes from inlet opening 238 down toward a position beneath and aligned with axis 232. A gas opening 244 fluidly connects passage 242 to the interior of the leg terminating with outlet opening 230. Opening 244 is directly aligned with the path of motion of the dross as it rises in the outlet leg of the conduit. The gas opening is illustrated as a single opening however it can comprise a series of gas injecting nozzles, each having a diameter of .020" to

.500" to form a gas jet into the conduit. High pressure gas is used so the gas momentum adds to the dross velocity and improves the suction efficiency of the pump.

The outlet leg of the conduit has a converging/diverging nozzle 245 aligned with gas nozzle 244. The configuration of the nozzle shape has the following approximate ratios:

$$W_T = .90\,W_{in} \text{ to } .60\,W_{in}$$

$$W = Width$$

$$W_{in} = \frac{3.50\,in}{4.50\,in};\ L_{in} = \frac{.60\,W_{in}}{.80\,W_{in}};\ L_1 = \frac{.30\,W_{in}}{.50\,W_{in}};\ \text{and}$$

$$L_o = \frac{16.0_{in}}{20.0_{in}} \bullet W_0 = W_{in}$$

$$L = Length$$

The gas can be delivered either in a continuous or an intermittent form. In either case the gas emerges through opening 244 and forms a series of spaced bubbles 246 because of the surface tension. The bubbles rise in the molten aluminum and dross. The rising bubbles entrap sections of molten aluminum and dross between them and carry them upwardly in the direction of axis 232.

By applying an intermittent flow of gas as shown in Figure 7, the utilization of the gas can be optimized by adjusting the frequency of the jet and bubble formation and the expansion rate to match a particular application. The rising bubbles induce a flow of molten metal towards outlet opening 230, generating a suction at inlet opening 228 which causes the dross located on the surface of the bath to move in the direction of arrow 248 into the inlet opening. A flow is created in conduit 226, thereby scavenging the dross from inside snout housing

18 to a location outside the housing where it can be skimmed off or removed by conventional means.

Referring now to Figure 12, a dross diluting pump 24 is depicted. Generally, pump 24 can be constructed of the same materials described above with respect to the dross removing pump. The primary distinction is that the pump flow direction has been reversed by changing the pump gas inlet position, thus introducing fresh metal into the snout internal chamber. In this manner, molten metal is drawn into pump 24 through inlet 330 and released at pump outlet 332 into the dross layer 21, diluting the dross layer. While beneficial alone, the simultaneous interaction of a dross diluting pump 24 and a dross removing pump 22 (see Figure 1) results in an excellent minimization of dross levels and improved metal treating.

Preferably, the elements of the pump are comprised of graphite, ceramic or molten metal resistant alloys according to the considerations discussed above. Furthermore, the gas delivery system will be the same as described above. Accordingly, gas travels down passage 322 in gas delivery leg 326 and exits through jet orifice 334 forming bubbles in outlet leg 336 of pump body 328--along axis 338--drawing metal into inlet leg 340. In this manner, "clean" metal is pulled from outside snout housing 18 and infused into the dross layer 21 inside the snout housing through pump outlet 332.

Turning to an alternative form of the dross diluting pump, reference is made to Figure 13. In this embodiment, a similar construction is provided, however, the pump is a hybrid, comprised of a combination of graphite and

ceramic elements. In this manner, the device is particularly suited for use in aluminum environments. Specifically, a gas delivery leg 426 is constructed of a first graphite body 428, including bore 429 and a protective ceramic sleeve 430. Leg 426 is threadedly connected to a graphite base element 432 including a gas delivery passage 434. Bore 429 and passage 434 are fluidly connected. Base element 432 is connected, preferably with cement, to pump body 436 which is preferably comprised of ceramic. Pump body 436 includes inlet opening 438 to inlet leg 439, and outlet opening 440 from outlet leg 441. Gas from the type of system described above is injected as a jet through orifice 442 along the vertical axis 444 of outlet leg 441. In this manner, "clean" metal is drawn upwardly to dilute dross layer 21 inside housing 18.

Turning next to Figure 14, an alternative embodiment of the dross diluting pump is depicted wherein a convergent/divergent nozzle 502 is utilized. In this regard, the design and function of nozzle 502 is equivalent to that described above in the dross removing embodiment (see Figures 10 and 11) and can be constructed in accord with the above-detailed shape. Furthermore, the convergent/divergent nozzle can be employed in any style of dross diluting pump; including the pump of Figure 12.

Thus it is apparent that there has been provided, in accordance with the invention a pump that fully satisfies the objects, aims, and advantages set forth above. While the invention has been described in conjunction with specific embodiments thereof, it is evident that many alternatives, modifications, and variations will be apparent to those skilled in the art in light of the foregoing

description. Accordingly, it is intended to embrace all such alternatives, modifications, and variations as fall within the spirit and broad scope of the appended claims.

Having described my invention, I claim:

Claims

1. In a metal treating apparatus having a container for holding a bath of molten metal, a gas-filled housing for enclosing a moving strip of metal, the housing having an opening in said bath of molten metal below the level thereof, through which the strip of metal exits the housing while submerged in the molten metal, and an apparatus for removing a layer of dross from the surface of the metal bath inside the gas-filled housing, comprising:

a conduit having an inlet opening adjacent the surface of the molten metal for receiving dross into the conduit;

the conduit having an outlet opening for discharging dross received through said inlet opening;

the conduit having a gas-receiving opening below the outlet opening, such that a gas rises in said conduit to induce a flow of dross into said inlet opening and towards said outlet opening; and

the gas-receiving opening being disposed to discharge the gas into the conduit in the same direction s the dross flows in the conduit.

2. The apparatus of claim 1, in which the gas-receiving opening is disposed adjacent the lowest portion of the conduit, and vertically beneath the outlet opening.

3. The apparatus of claim 1, further comprising a second conduit for introducing the gas, attached to the first conduit, the first conduit comprising a

generally U-shaped member having a pair of vertical legs with openings in their respective upper ends for respectively receiving and discharging the dross.

4. The apparatus of claim 1, wherein said conduit is comprised of a material selected from stainless steel, temperature resistant alloy, graphite, ceramic or mixtures thereof.

5. The apparatus of claim 1, including an apparatus for introducing the gas intermittently into the conduit to form a series of spaced rising bubbles which entrap and move sections of molten metal and dross.

6. The apparatus of claim 1, including a vertically oriented gas delivery leg secured to a base member, said gas delivery leg having a gas passage in fluid communication with a gas duct in said base member, said conduit being secured to said base member wherein said gas-receiving opening is in fluid communication with said gas duct.

7. The apparatus of claim 1, further including a convergent/divergent nozzle in the conduit.

8. The apparatus of claim 7, in which the convergent/divergent nozzle is disposed between the gas receiving opening and the outlet opening.

9. The apparatus of claim 6, wherein said gas delivery leg is comprises of a graphite body housed in a ceramic sleeve.

10. A metal treating process in which a moving strip of metal passes through a bath of molten metal in a gas-filled housing which encloses the moving strip of metal, the housing having an opening in said bath of molten metal below the level thereof, through which the strip of metal exits the housing while submerged in the molten metal, a method for moving a material selected from molten metal, dross or mixtures thereof inside the gas-filled housing, comprising:

positioning a conduit having an inlet opening adjacent either the surface of the molten metal for receiving dross into the conduit, or below the surface for receiving molten metal and an outlet opening for discharging the received dross or molten metal; and

introducing a gas into the conduit in the same direction as the motion of the metal or dross, whereby the gas rises in the conduit to induce a flow of dross into the inlet opening and towards the outlet opening.

11. An apparatus for removing a layer of dross from the surface of a metal bath comprising a generally U-shaped conduit including a first let having an inlet opening, and a second leg having an outlet opening for discharging dross receiving through said inlet opening, the second leg having a longitudinal axis wherein a gas-receiving opening and the outlet opening lie generally on said longitudinal axis.

12. The apparatus of claim 11, including a pump body mated with the conduit adjacent the gas-receiving opening, an elongated gas delivery member having a gas passage for delivering gas and a lower end threadably connected to a threaded section of the pump body and an upper end extending above the U-shaped conduit and adapted for receiving a gas, and a sleeve encasing the gas delivery member.

13. The apparatus of claim 12, in which the pump body is formed of graphite.

14. The apparatus of claim 12, in which the gas delivery member is formed of graphite, and the sleeve is formed of a ceramic.

15. The apparatus of claim 11, in which the conduit is formed of a ceramic.

16. The apparatus of claim 11, including a tubular member forming a gas delivery element.

17. In a metal treating apparatus having a container for holding a bath of molten metal, a gas-filled housing for enclosing a moving trip of metal, the housing having an opening in said bath of molten metal below the level thereof,

through which the strip of metal enters the housing while submerged in the molten metal, and an apparatus for diluting a layer of dross at the surface of the metal bath inside the gas-filled housing, comprising:

a conduit having an inlet opening below the surface of the molten metal;

the conduit having an outlet opening adjacent the layer of dross;

the conduit having a gas-receiving opening below the outlet opening such that gas rises in said conduit to induce a flow of metal into said inlet opening and towards said outlet opening; and

the gas-receiving opening being disposed to discharge the gas into the conduit in the same direction as metal flows in the conduit.

18. The apparatus of claim 16, further including a convergent/divergent nozzle in the conduit.

19. An apparatus for diluting a layer of dross at the surface of a metal bath comprising a generally U-shaped conduit having a first let having an inlet opening, and a second leg having an outlet opening for discharging metal received through said inlet opening, the conduit having a gas-receiving opening below the outlet opening,

a pump body mated with the conduit adjacent the gas-receiving opening;

an elongated gas delivery member having a lower end threadably connected to a threaded section of the pump body and an upper end, extending above the second leg and adapted for receiving a gas; and

a sleeve encasing the gas delivery member, the sleeve having an upper end above the second leg, said pump body and said gas delivery member including a gas passage for delivering gas into said conduit.

20. The apparatus of claim 19, in which the body is formed of graphite.

21. The apparatus of claim 20, in which the gas delivery member is formed of graphite and the sleeve is formed of a ceramic.

22. An apparatus for moving a material selected from the group consisting of dross molten metal and mixtures thereof in a metal bath comprising a generally U-shaped conduit including a first leg having an inlet opening, and a second leg having an outlet opening, the second leg having a longitudinal axis wherein a gas receiving opening and the outlet opening lie generally on said longitudinal axis.

23. The apparatus of claim 22, being comprised of a material selected from the group consisting of ceramic, graphite, and mixtures thereof.

24. The apparatus of claim 22, including a pump body mated with the conduit adjacent the gas receiving opening, an elongated gas delivery member having a gas passage for delivering gas into said conduit and a lower end threadably connected to a threaded section of the pump body and an upper end, extending above the U-shaped conduit and adapted for receiving a gas, and a sleeve encasing the gas delivery member.

25. The apparatus of claim 11, including a tubular member forming a gas delivery element.

Abstract of Disclosure

A gas jet-operated pump for removing dross from the surface of a bath of molten metal. The pump can be employed for delivering molten metal to the dross for diluting it or for removing it from a selected area.

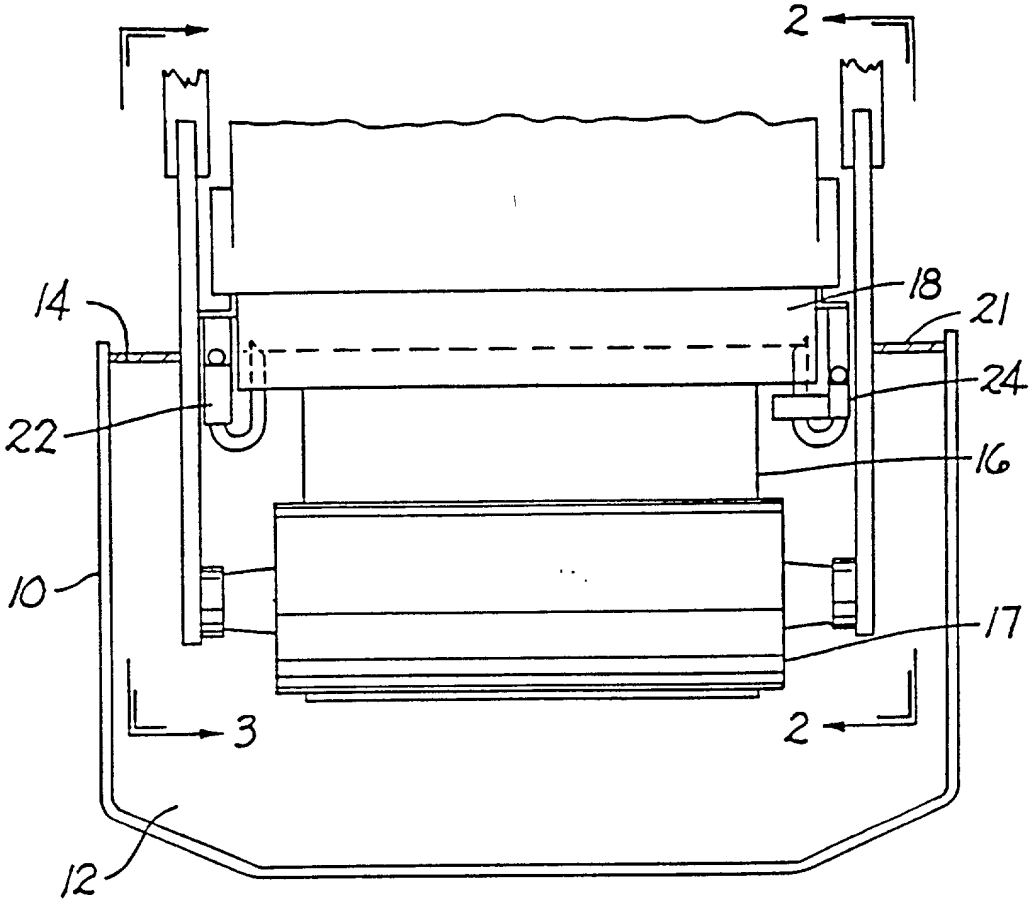


FIG. 1

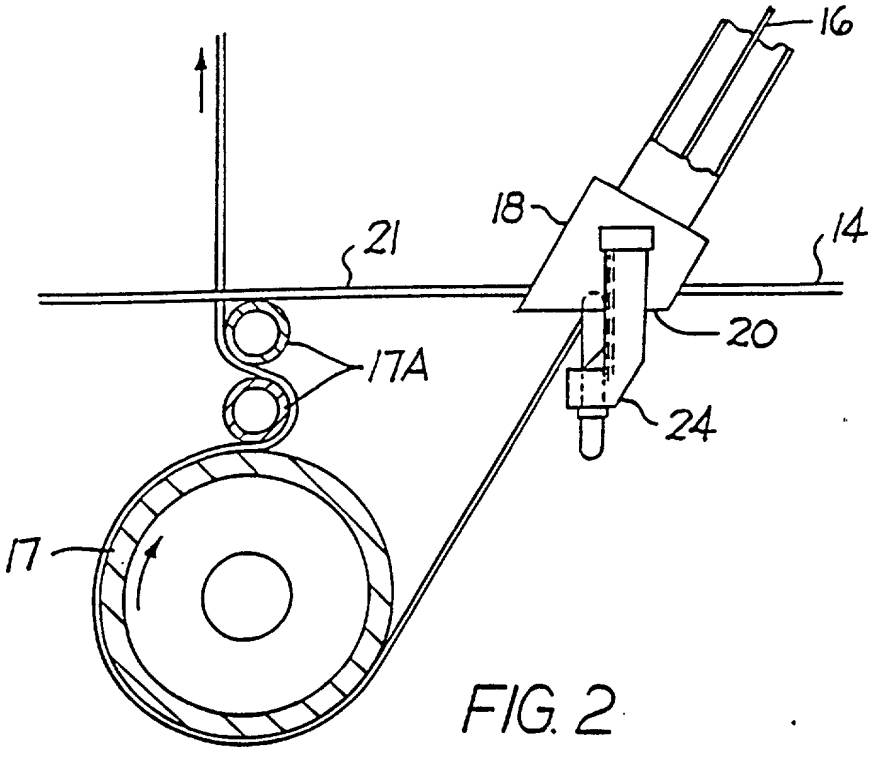


FIG. 2

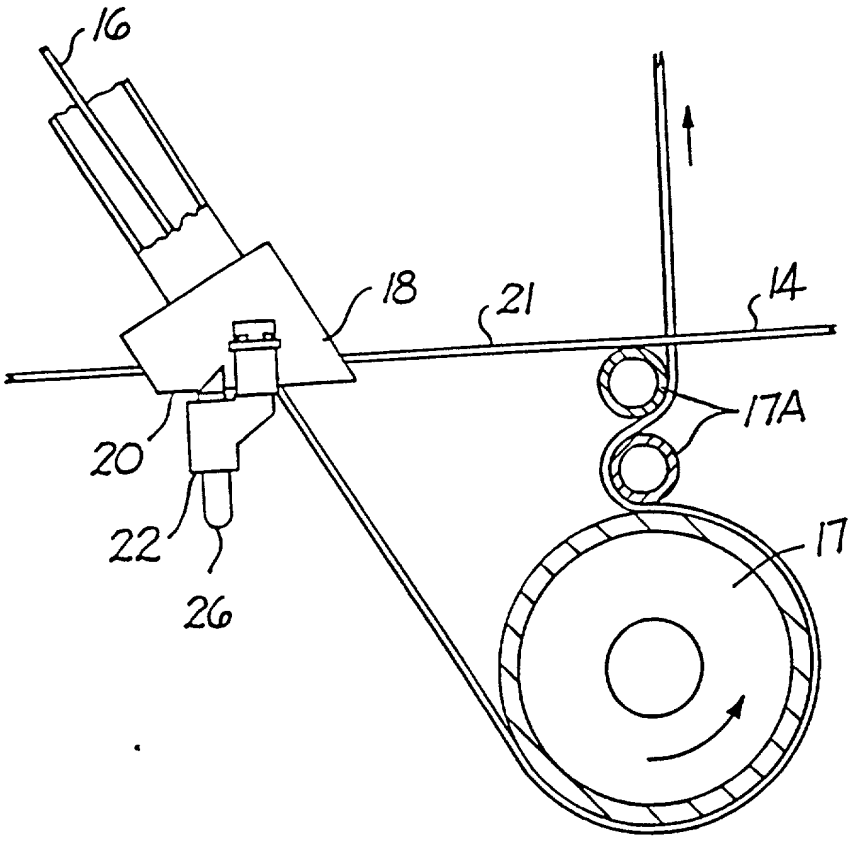


FIG. 3

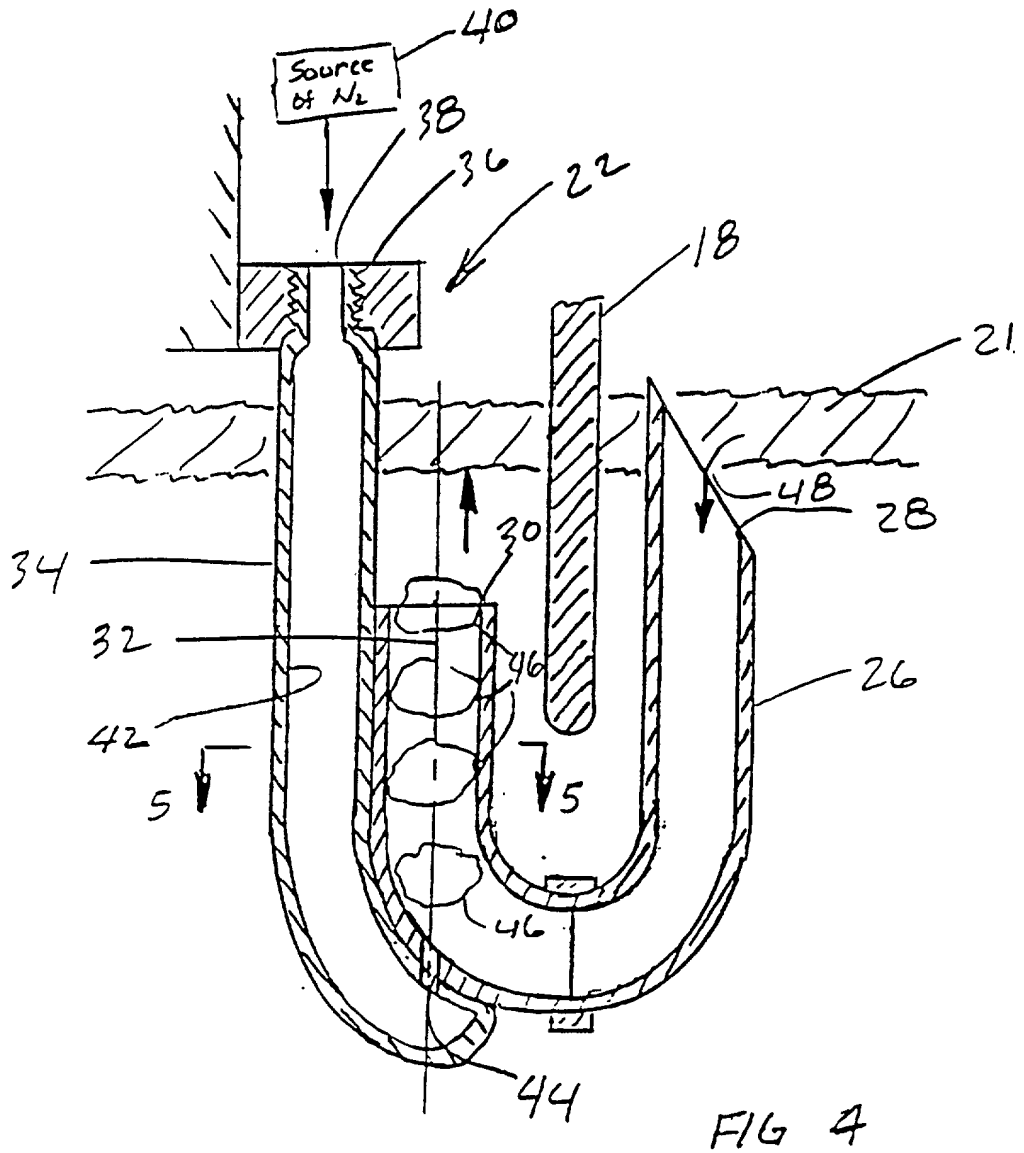


FIG 4

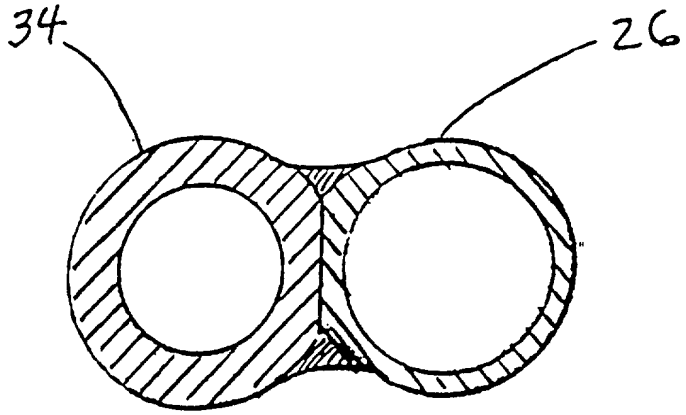
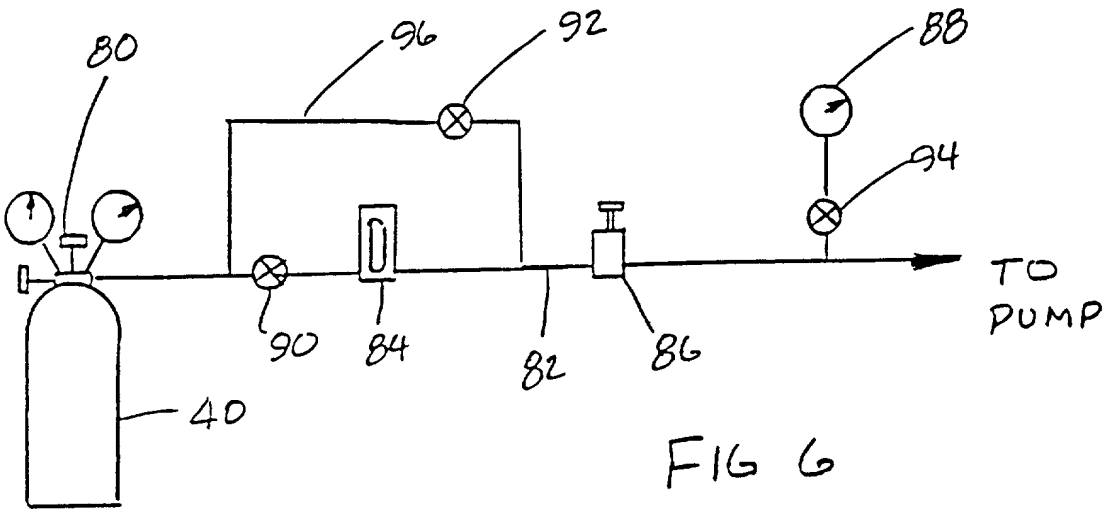


FIG 5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86
40

FIG 6

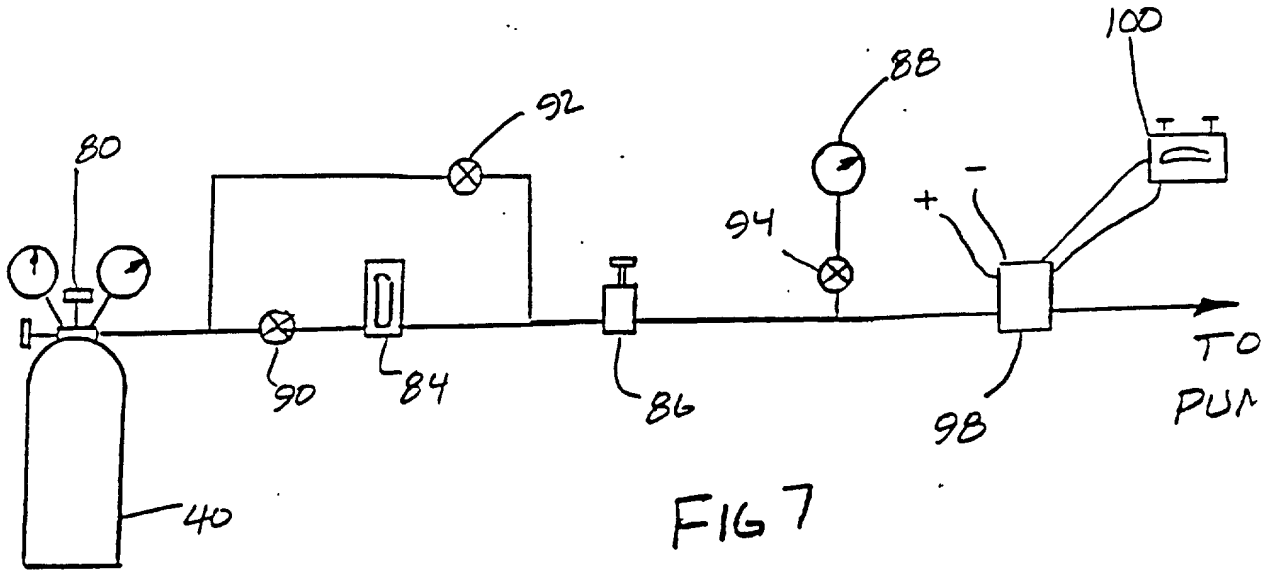
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FIG 7

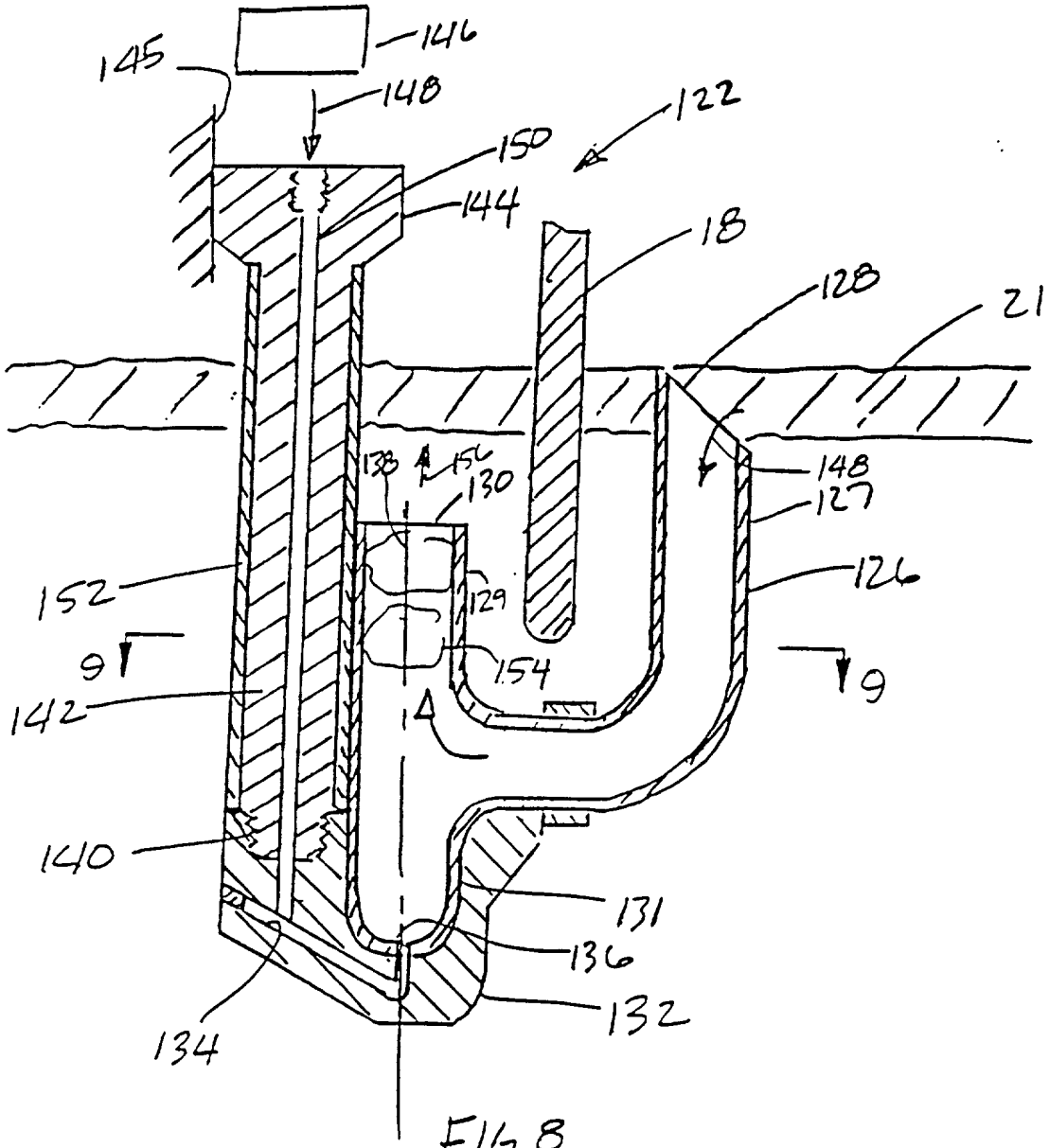
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FIG 8

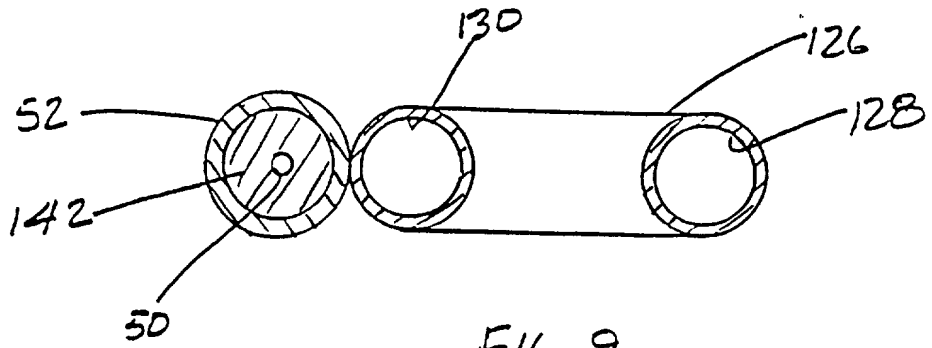
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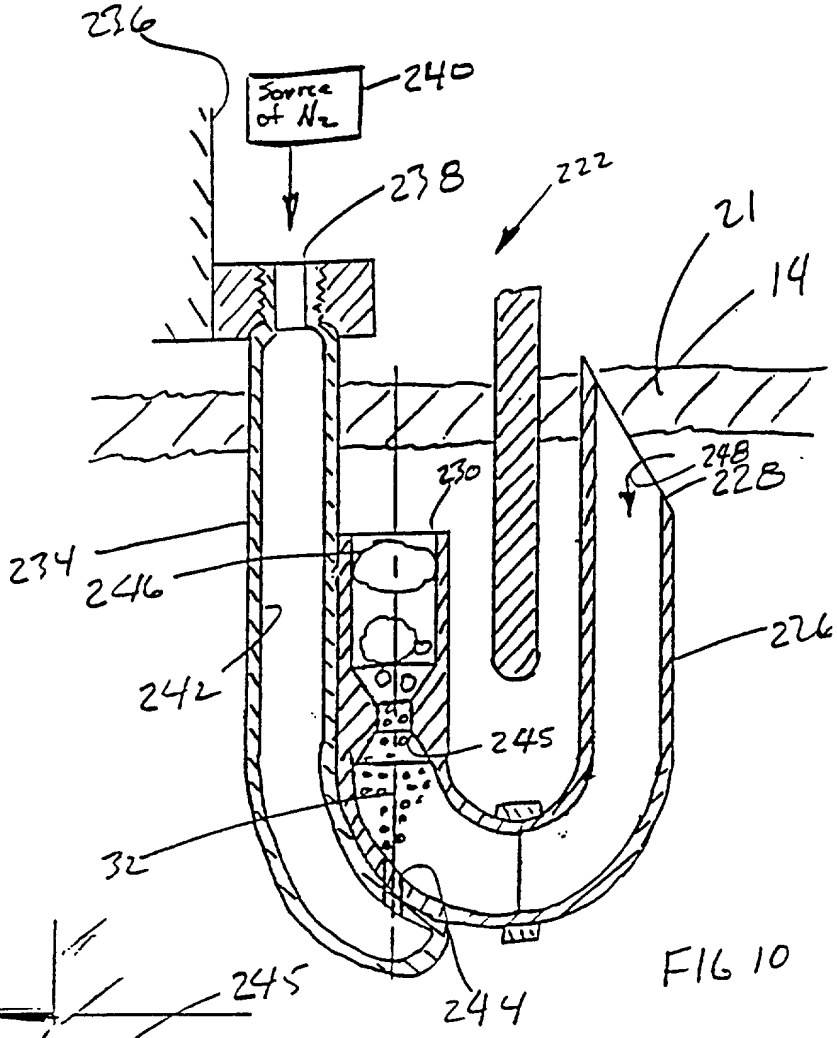
FIG 9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Source of N_2
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FIG 10

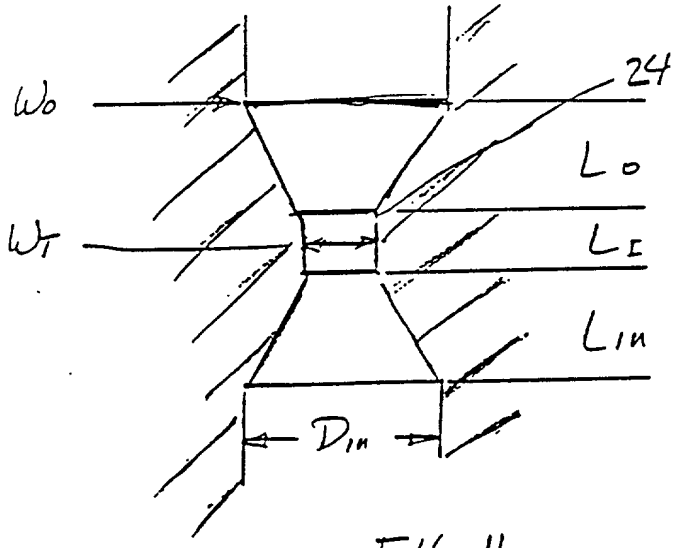

W_O
W_I
245
L_O
L_I
L_{IN}
D_{IN}

FIG 11

Figure 12

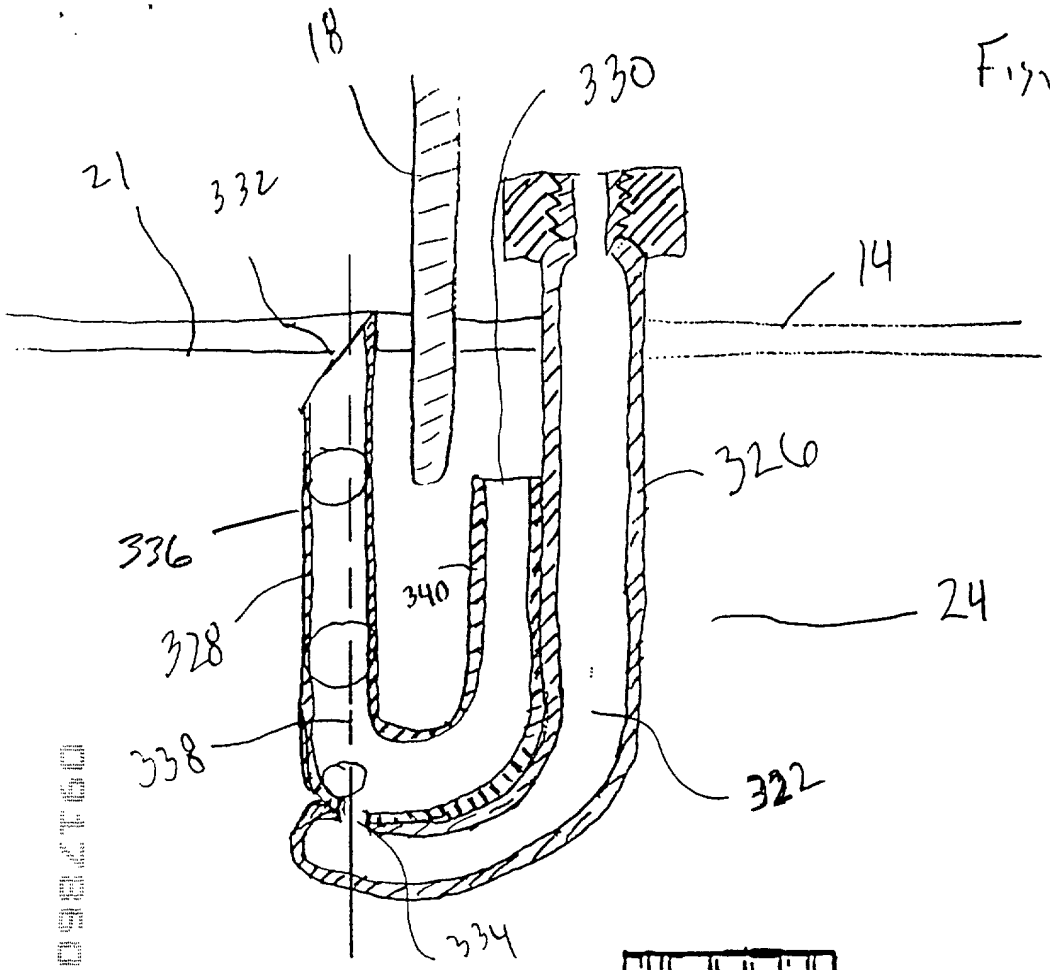
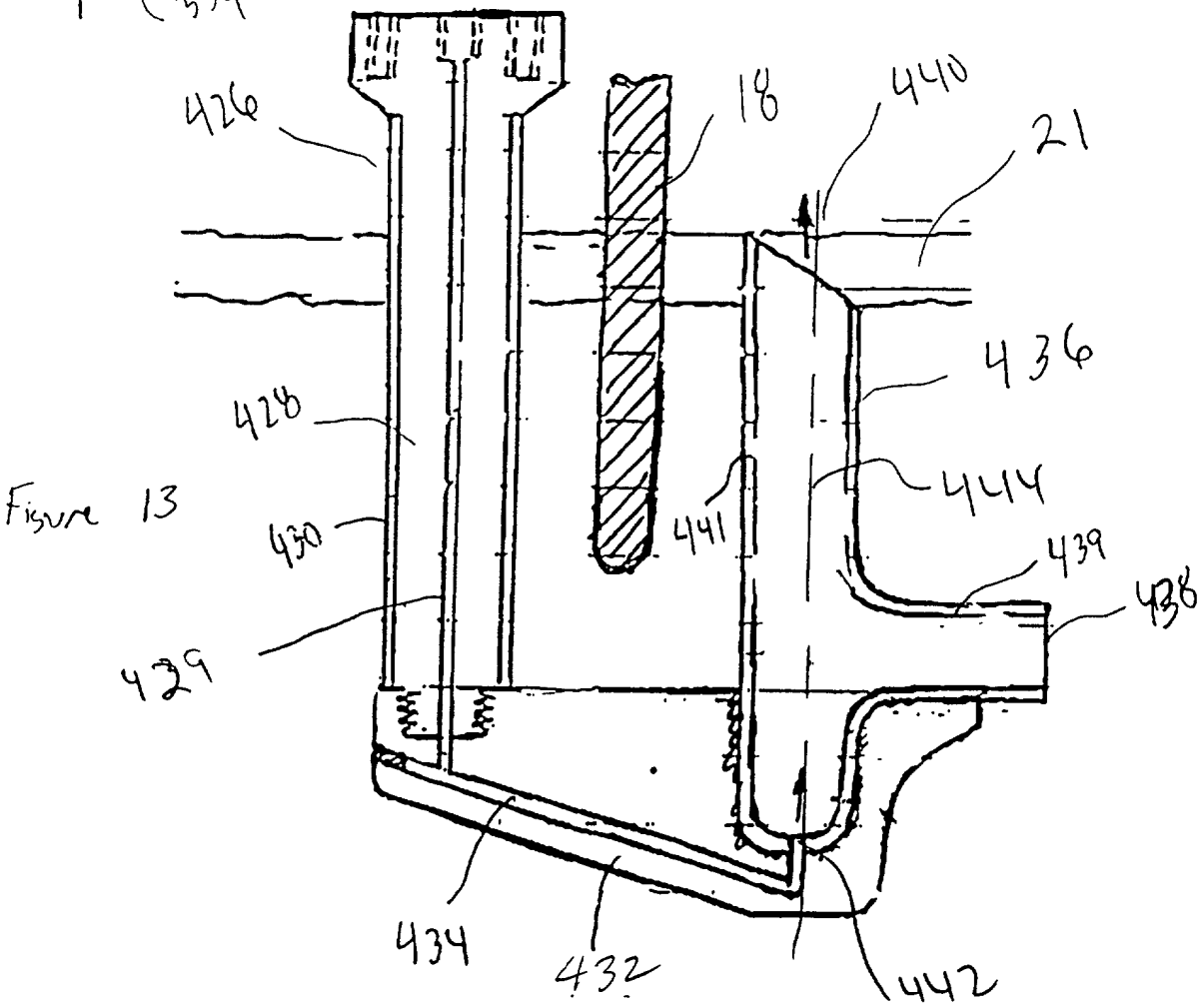


Figure 13



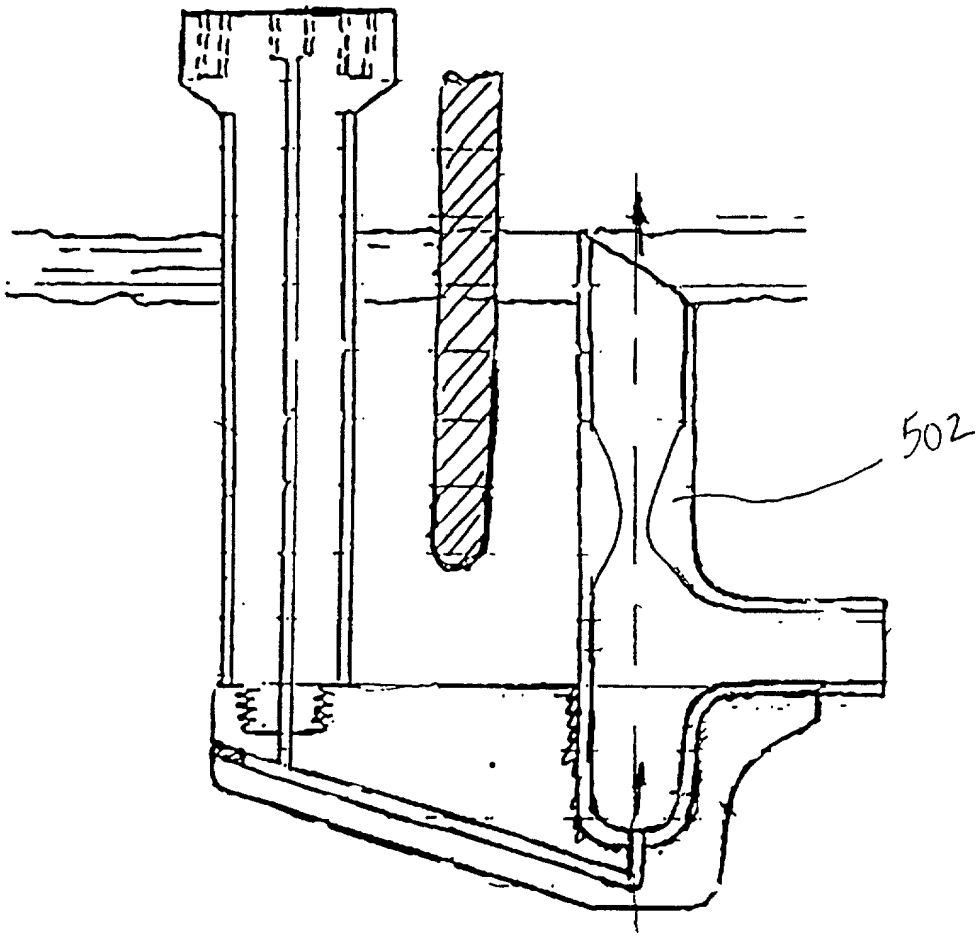


Figure 14

Type a plus sign (+) inside this box → [+]

Approved for use through 9/30/98 OMB 0651-0032
Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

0010/PTO Rev 5/95 — U.S. Department of Commerce, Patent and Trademark Office

DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION

[X] Declaration Submitted with Initial Filing OR [ ] Declaration Submitted after Initial Filing

Attorney Docket Number	MJV-104-E
First Named Inventor	Jorge A. Morando
COMPLETE IF KNOWN	
Application Number	
Filing Date	
Group Art Unit	
Examiner Name	

As a below named inventor, I hereby declare that:

My residence, post office address, and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

JET COLUMN AND JET COLUMN REACTOR DROSS REMOVING AND DROSS DILUTING PUMPS

(Title of the invention)

the specification of which

[X] is attached hereto

OR

[ ] was filed on (MM/DD/YYYY) [ ] as United States Application Number or PCT International Application Number [ ] and was amended on (MM/DD/YYYY) [ ] (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37 Code of Federal Regulations, §1.56.

I hereby claim foreign priority benefits under Title 35, United States Code §119 (a)-(d) or §365(b) of any foreign application(s) for patent or inventor's certificate, or §365 (a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or of any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Not Claimed	Certified Copy Attached? YES	NO
			[ ]	[ ]	[ ]

[ ] Additional foreign application numbers are listed on a supplemental priority sheet attached hereto:

I hereby claim the benefit under Title 35, United States Code §119(e) of any United States provisional application(s) listed below.

Application Number(s)	Filing Date (MM/DD/YYYY)	
		[ ] Additional provisional application numbers are listed on a supplemental priority sheet attached hereto.

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Type a plus sign (+) inside this box → [+]

DECLARATION

I hereby claim the benefit under Title 35, United States Code §120 of any United States application(s), or §365(c) of any PCT international application designating the United States of America, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT international application in the manner provided by the first paragraph of Title 35, United States Code §112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application

U.S. Parent Application Number	PCT Parent Number	Parent Filing Date (MM/DD/YYYY)	Parent Patent Number (if applicable)
08/876,636		06/16/1997	
08/876,668		06/16/1997	
08/876,669		06/16/1997	
08/489,322		06/12/1995	
		11/04/1997	5,683,650

☐ Additional U.S. or PCT international application numbers are listed on a supplemental priority sheet attached hereto.

As a named inventor, I hereby appoint the following registered practitioner(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith:

☐ Firm Name
OR
☒ List registered practitioner(s) name and registration number below:

Customer Number or label

Name	Registration Number	Name	Registration Number
Charles W. Chandler	24,290		

☐ Additional registered practitioner(s) named on a supplemental sheet attached hereto.

Please direct all correspondence to: ☐ Customer Number or label OR ☒ Correspondence address below

Name	Charles W. Chandler				
Address	33150 Schoolcraft				
Address					
City	Livonia	State	MI	ZIP	48150
Country	U.S.A.	Telephone	(734) 522-0920	Fax	(734) 522-5657

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon

Name of Sole or First Inventor: ☐ A petition has been filed for this unsigned inventor

Given Name	Jorge	Middle Initial	A.	Family Name	Morando	Suffix e.g. Jr.	

Inventor's Signature: Jorge A. Morando Date: Sept 28 1998

Residence: City	Cadiz	State	KY	Country	U.S.A.	Citizenship	U.S.A.

Post Office Address	526 Riverview Trail
Post Office Address	

City	Cadiz	State	KY	Zip	42211	Country	U.S.A.	Applicant Authority	

☐ Additional inventors are being named on supplemental sheet(s) attached hereto

PTO/SB/10 (6-95)
Approved for use through 07/31/96. OMB 0651-0031
Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

VERIFIED STATEMENT CLAIMING SMALL ENTITY STATUS (37 CFR 1.9(f) & 1.27(c))--SMALL BUSINESS CONCERN

Docket Number (Optional): MJV-104-E

Applicant or Patentee: Jorge A. Morando
Application or Patent No.: _____
Filed or Issued: _____
Title: JET COLUMN AND JET COLUMN REACTOR DROSS REMOVING AND DROSS DILUTING PUMPS

I hereby declare that I am
☐ the owner of the small business concern identified below:
☒ an official of the small business concern empowered to act on behalf of the concern identified below:

NAME OF SMALL BUSINESS CONCERN Alphatech, Inc.
ADDRESS OF SMALL BUSINESS CONCERN 526 Riverview Trail
Cadiz, KY 42211

I hereby declare that the above identified small business concern qualifies as a small business concern as defined in 13 CFR 121.12, and reproduced in 37 CFR 1.9(d), for purposes of paying reduced fees to the United States Patent and Trademark Office, in that the number of employees of the concern, including those of its affiliates, does not exceed 500 persons. For purposes of this statement, (1) the number of employees of the business concern is the average over the previous fiscal year of the concern of the persons employed on a full-time, part-time or temporary basis during each of the pay periods of the fiscal year, and (2) concerns are affiliates of each other when either, directly or indirectly, one concern controls or has the power to control the other, or a third party or parties controls or has the power to control both.

I hereby declare that rights under contract or law have been conveyed to and remain with the small business concern identified above with regard to the invention described in:

☒ the specification filed herewith with title as listed above.
☐ the application identified above.
☐ the patent identified above.

If the rights held by the above identified small business concern are not exclusive, each individual, concern or organization having rights in the invention must file separate verified statements averring to their status as small entities, and no rights to the invention are held by any person, other than the inventor, who would not qualify as an independent inventor under 37 CFR 1.9(c) if that person made the invention, or by any concern which would not qualify as a small business concern under 37 CFR 1.9(d), or a nonprofit organization under 37 CFR 1.9(e).

Each person, concern or organization having any rights in the invention is listed below:
☐ no such person, concern, or organization exists.
☒ each such person, concern or organization is listed below.

Jorge A. Morando
526 Riverview Trail
Cadiz, KY 42211

Separate verified statements are required from each named person, concern or organization having rights to the invention averring to their status as small entities. (37 CFR 1.27)

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28(b))

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

NAME OF PERSON SIGNING Jorge A. Morando

TITLE OF PERSON IF OTHER THAN OWNER President

ADDRESS OF PERSON SIGNING 526 Riverview Trail

SIGNATURE _____ DATE Sept 28 1998

PTO/SB/09 (6-95)
Approved for use through 07/31/96. OMB 0651-0031
Patent and Trademark Office: U.S DEPARTMENT OF COMMERCE

VERIFIED STATEMENT CLAIMING SMALL ENTITY STATUS (37 CFR 1.9(f) & 1.27(b))—INDEPENDENT INVENTOR

Docket Number (Optional) MJV-104-E

Applicant or Patentee: Jorge A. Morando

Application or Patent No.: _____

Filed or Issued: _____

Title: JET COLUMN AND JET COLUMN REACTOR DROSS REMOVING AND DROSS DILUTING PUMPS

As a below named inventor, I hereby declare that I qualify as an independent inventor as defined in 37 CFR 1.9(c) for purposes of paying reduced fees to the Patent and Trademark Office described in:

- [X] the specification filed herewith with title as listed above.
- [ ] the application identified above.
- [ ] the patent identified above.

I have not assigned, granted, conveyed or licensed and am under no obligation under contract or law to assign, grant, convey or license, any rights in the invention to any person who would not qualify as an independent inventor under 37 CFR 1.9(c) if that person had made the invention, or to any concern which would not qualify as a small business concern under 37 CFR 1.9(d) or a nonprofit organization under 37 CFR 1.9(e).

Each person, concern or organization to which I have assigned, granted, conveyed, or licensed or am under an obligation under contract or law to assign, grant, convey, or license any rights in the invention is listed below:

- [ ] No such person, concern, or organization exists.
- [X] Each such person, concern or organization is listed below.

Alphatech, Inc.
526 Riverview Trail
Cadiz, KY 42211

Separate verified statements are required from each named person, concern or organization having rights to the invention averring to their status as small entities. (37 CFR 1.27)

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28(b))

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

NAME OF INVENTOR	NAME OF INVENTOR	NAME OF INVENTOR
Jorge A. Morando		
Signature of inventor	Signature of inventor	Signature of inventor
Sept 28 1998		
Date	Date	Date